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The Attitude of Smallholder Farmers towards Uptake of Potato Crop Intensification Innovations in Southwestern Uganda

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Abstract

Despite the potential of potato crop intensification innovations to improve potato yield and productivity, the attitude of most smallholder farmers towards them remains negative, thus low uptake. This study investigates the role of farmers' attitudes in the uptake of potato crop intensification innovations among smallholder farmers in Southwestern Uganda. The districts of Rubanda, Kabale, and Rukiga were purposively selected because of their active participation in demonstration, research, training and dissemination activities under Community Action Research Programme Plus (CARP+), a RUFORUM project that was implemented by Makerere University between 2018 and 2021 in Southwestern Uganda. Quantitative data was collected from 265 smallholders through a survey and analysed using descriptive statistics. Results revealed that despite a general shift from traditional practices to potato crop intensification innovations, attitude towards some potato crop intensification innovations such as use of fertilizers and improved seed remained lower. Preference for research station as a credible source of potato seed remained lower particularly for Rukiga district while small-size tubers remained the most preferred planting material among farmers. Finally, preference for use of farmyard manure remained lower across all districts, thus paving way for limited potential of potato yield, productivity and environmental vulnerability. The study recommended continuous extension educational programmes to create awareness and clear extension messages on benefits of using innovative practices such as quality declared seed and organic fertilizers. It was also recommended that Kachwekano-ZARDI establishes certification processes and protocols for informal seed players such as farmers, local stores and local markets to ensure seed quality and accessibility.

Subject Areas

Agricultural Science

Keywords

Extension Education, Farmer Attitudes, Innovation Uptake, Potato Intensification, Smallholder Farmers

1. Introduction

Farmers' attitudes play a critical role in the uptake of new farming practices [1]-[4]. Attitudes, defined as the positive or negative evaluations of an individual towards a new practice, process or idea play a central role in determining whether an individual decides to adopt or reject its uptake [3] [5]. Thus, a positive attitude enhances the probability of uptake, while a negative attitude diminishes it [4] [6].

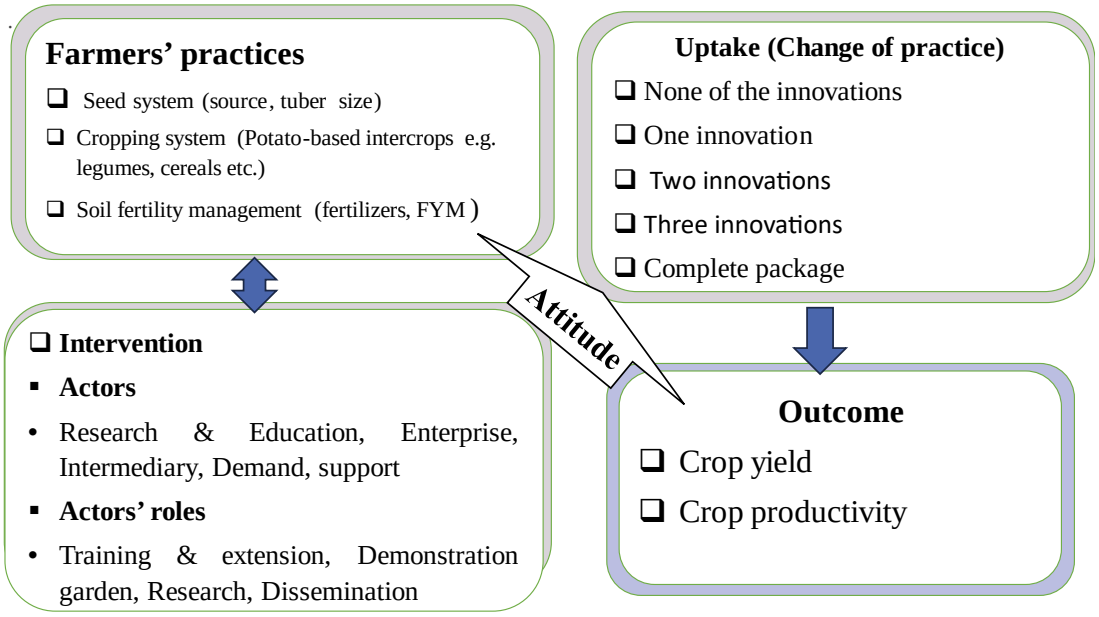
Attitude is a key factor in decision-making processes [7]-[13], it is influenced by the socioeconomic and institutional contexts of the farmer such as gender, age, education, access to extension service [1]. As such, understanding factors that shape attitude is essential for designing effective interventions that promote uptake of modern farming practices.

Attitudes influence uptake of modern farming practices which in turn influence agricultural productivity and sustainability [8] [11]-[16] useful to manufacturers and innovation developers to identify the behaviour of adopters and to develop innovations that satisfy their needs. In particular, they can encourage the development of fruitful technological trajectories that are requested by users, as well as to differentiate products according to the different propensity of the adopter towards the technological features of agricultural tractors.

Attitudes towards agricultural innovation are primarily determined by the farmer's knowledge and perception on that innovation [3]. As such, the characteristics of the farmer play a pivotal role in shaping their attitudes [5] [17]. These characteristics may be socioeconomic or institutional in nature such as gender, age, access to extension services and markets [3] [18]. For instance, an effective extension services can enhance the farmers' capacity to make well-informed decisions by bridging the gap between research and practice [19]-[21]. This improves farmers' capacity to evaluate the potential benefits of adopting modern farming practices [10] [22] [23]. Similarly, enterprises such as farmer groups can guarantee access to agricultural markets and credit [21] [24] [25] hence fostering an attitude towards an innovation. The study examines the role of farmers' attitudes towards the uptake of potato crop intensification innovation following the Community Action Research Programme (CARP+), a Ruforum project that was implemented by Makerere University in Southwestern Uganda. Factors such as the perceived benefits and costs of the innovation and its overall contribution to farm productivity are critical in forming positive or negative attitudes [3].

Theoretical and Conceptual Framework

External factors such as training and extension service and the characteristics of an innovation such as ease of use influence the attitude potential adopters develop towards a new production practice [3] (**Figure 1**).



Source: Adapted form [3] [26] [27].

Figure 1. Interaction between characteristics of an innovation and intervention.

When an external factor such as an intervention is introduced through training and dissemination, the attitudes of the potential users tend to change in favour or against. If the new practice promises value in terms of ease of use, usefulness and/or both, the users' perception changes in favour of uptake [3]. This attitude is closely related to the knowledge and perception the individual already has towards this practice. Whereas knowledge refers to factual information and understanding of how the innovation works and what it can achieve, perception relates to the views farmers hold about the practice based on their felt needs which may not necessarily align with reality [10] [28]. The knowledge and perceptions about a new practice (innovation) can be reinforced with an intervention to influence the attitude toward it [3]. Whereas a positive attitude towards an agricultural innovation increases the likelihood of uptake, a negative attitude reduces the probability of its uptake [29] [30]. Attitude can also be influenced by the personal characteristics of the farmer such as gender, age, marital status, income, and education [2].

2. Methodology

2.1. Research Design

A descriptive cross-sectional survey was conducted using semi structured face-to-face interviews with respondents. The research design employed a quantitative

approach to collect data and analysis techniques focusing on smallholder farmers who actively involved in CARP+ project research, training, demonstration and dissemination activities on potato crop intensification innovation. A semi-structured questionnaire was administered to provide a comprehensive analysis of farmers' attitudes towards various aspects of potato crop intensification innovation aspects such as source of seed, size of tubers used for seed, intercropping systems and soil fertility enhancement practices.

2.2. Study Area

The study was conducted in in three major potato growing districts in Southwestern Uganda where about 60% of national potato output is produced [31]. These districts were selected based on their involvement in research, training, demonstration and dissemination activities aimed at promoting potato crop intensification innovations introduced by CARP+, a Regional Universities Forum (RUFORUM) initiative led by Makerere University. These farmers were considered to have first-hand experience and knowledge of the project's interventions and were thus ideal respondents for this study. This therefore makes the area more appropriate for the study.

2.3. Sampling and Data Collection

To collect quantitative data, a multi-stage sampling technique was used to select a representative sample of farmers from the three districts. In the first stage, a district where CARP+ project implemented research, training, demonstration and dissemination activities was selected and a Sub County where the demonstration site was located was purposively selected and a random sample of farmers who had participated in the project activities was chosen to generate a sampling frame with a total of 2027 smallholder farmers (Table 1). Using Glenn's table (precision ±5%; p = 0.05 and confidence interval 95%) a total sample of 333 respondents was raised (Glenn, 1992). For each demonstration site, a proportionate stratified sampling strategy was employed to generate the number of smallholder farmers selected for the study. However, the response rate was about 80%, thus Rubanda (86), North Division (106) and Rukiga (73).

Table 1. Farmers selected for the study.

District	Study population	Sample size	Actual number interviewed
Rukiga	691	114	73
Kabale	658	108	106
Rubanda	678	111	86
Total	**2027**	**333**	**256**

2.4. Data Analysis

Descriptive statistics were used to analyze the data using Excel software to describe

the data using means, frequencies, and percentages.

3. Results and Discussion

3.1. Descriptive Characteristics of Smallholder Farmers

Findings revealed that the mean age of respondents was 46 years (Table 2). This age bracket tends to be experienced with indigenous knowledge and skills. This age group lies within the age bracket (30 - 50 years) believed to be active in agriculture [2] [32] [33]. It is also within the age group (15 - 64) that is economically productive that can lead to massive production if efficiently used [34].

Table 2. Descriptive characteristics of smallholder farmers.

Socio-economic characteristics	Mean	SD	p-value
Age of the farmer (years)	46.00	12.65	0.105
Farming experience (years)	11.99	9.97	0.829
Education level of the farmer	6.60	4.06	0.032
Farm size (acres)	2.65	1.69	0.182
Dist. to agric. Market (km)	3.98	4.52	0.049
Dist. to tarmac road (km)	9.00	8.82	0.012
Dist. to marram road (km)	2.00	2.67	0.000
Dist. to agric. input shop (km)	4.38	4.70	0.334
Dist. to Trading Centre (km)	1.40	1.48	0.179

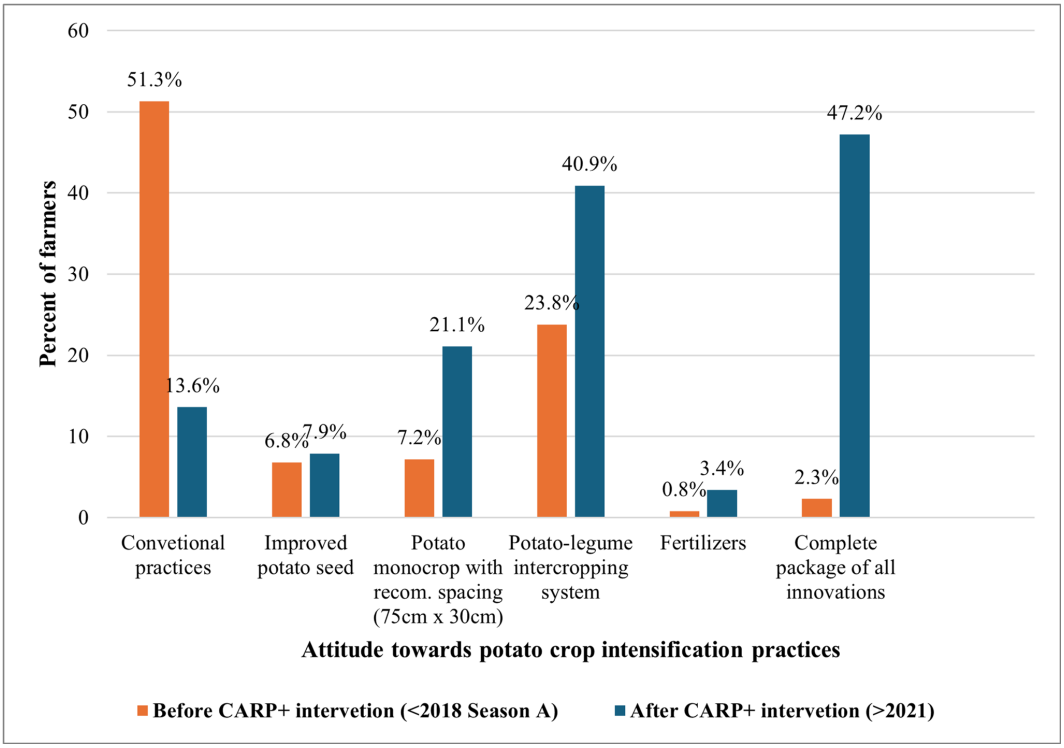
However, older farmers tend to fear risk, thus developing negative attitude towards new practices (innovations), often perceived as unnecessary [17]. It was further revealed that farmers had seven years in school (primary education). Education is a crucial component in shaping the attitude of farmers by enhancing their ability of farmers to make informed decisions for increased efficiency, productivity, profitability, and sustainability [35]. Previous author noted that farmers who complete primary education are able to read and write and can comprehend the most required information for uptake. Thus, crop intensification innovation needs good adherence to timely and recommended agronomic practices, particularly in fertilizer and pesticide application, and the use of improved seed [36] [37].

Further, it was revealed that smallholder farmers traveled four kilometers to access the nearest agricultural market and four kilometers to the input shop. A shorter distance to the market increases access to market information, and reduces travel time, hence, reducing transaction costs to and from the market which does not only reduce the overall cost of production Farmers also travelled nine kilometers to the tarmac road, two kilometers to the marram road and two kilometers to the nearest Trading Centre respectively. Access to the road and Trading Centres are proxies to market access, thus enhancing the farmers attitude and market participation. It affects the movement of agriculture products market, access to inputs and market information through easy access to market information,

agricultural inputs and access extension service [1].

3.2. Attitude of Smallholder Farmers toward Potato Crop Intensification Innovations before and after CARP+ Project

Survey results indicated a significant shift in farmers' attitudes (51.3%) from relying on traditional potato production practices compared to 13.6% for potato crop intensification innovations before CARP+ intervention (<2018 season A) to 47.2% attitude towards potato crop intensification practices compared to 2.3% for traditional potato production practices after the intervention (**Figure 2**).



Source: *Survey data*, 2022.

Figure 2. Attitude of smallholder farmers toward potato crop intensification innovations before and after the CARP+ intervention.

Notable was the improvement in attitude towards potato-legume intercropping system from 23.8% to 40.9% and potato monocropping with recommended spacing (75 cm × 30 cm) improved from about 7% to 21%. The reason for this was due to positive change in attitude as perceived by farmers to be more useful and ease of use due to the training, extension service, demonstration, and dissemination activities by CARP+ project. However, much as there was a slight improvement in attitude towards the use of improved seed from research station (6.8% to 7.9%) and use of fertilizers (0.8% to 3.4%), their uptake remained comparably lower. The low uptake of some of the innovative practices such innovations were logistical relating availability and access.

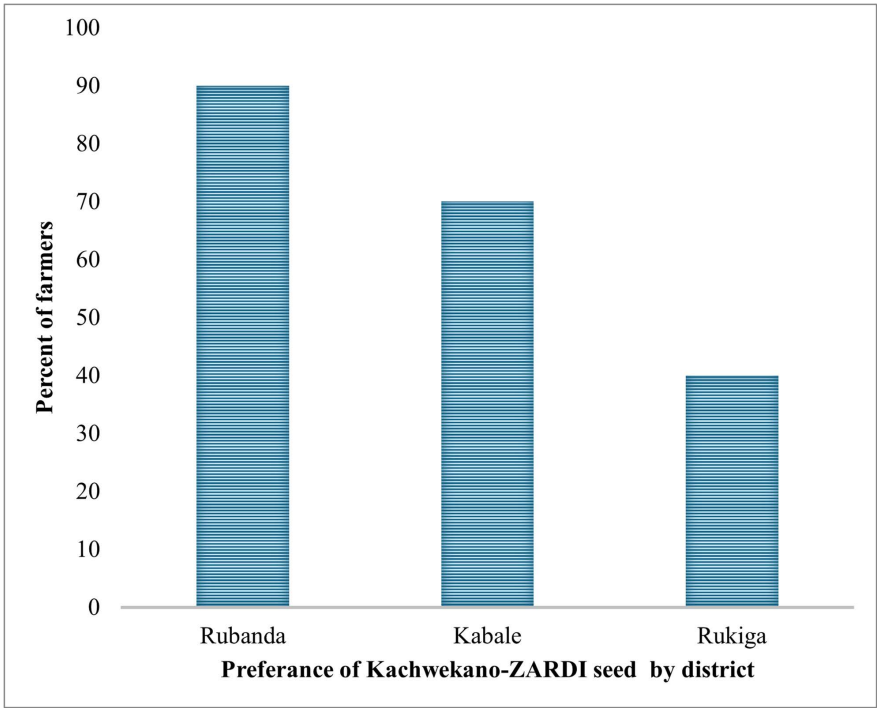
"*Fertilizers and potato seed from research station are so expensive, we cannot*

afford them" (Turyasingura Obed, a farmer in, Rukiga district).

From literature, fertilizers and quality seeds are an integral part of current agricultural production system to provide essential mineral elements for positive crop growth to full potential and blossoming harvests [37]-[39]. It is, therefore, imperative that clear extension messages and information dissemination to create awareness on benefits of using quality seed and fertilizers coupled with strengthening supply chain and distribution networks to ensure that quality seed and fertilizers are readily available and easily accessible for sustained adoption.

3.3. Attitude of Smallholder Farmers towards Research Station (Kachwekano-ZARDI) as a Credible Source of Improved Potato Seed

Survey results revealed that there was a significant regional variation in the preferred sources of potato seed among farmers in the Rubanda, Kabale, and Rukiga districts (**Figure 3**).



Source: *Field data*, 2022.

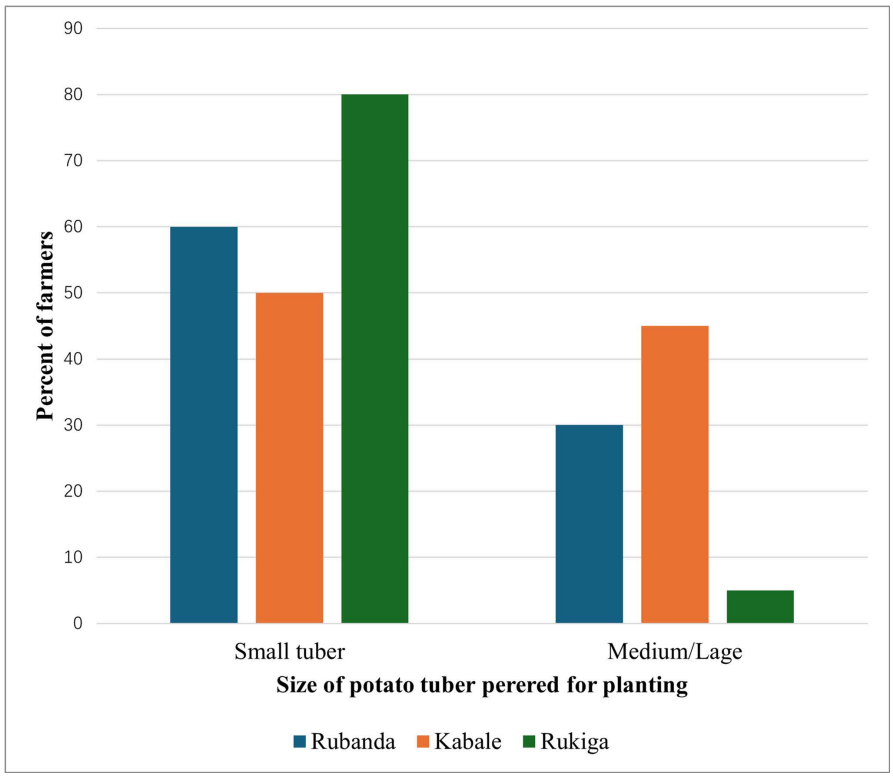
Figure 3. Preference of research station (Kachwekano-ZARDI) as credible source for quality seed.

Specifically, research station including Kachwekano-ZARDI are highly preferred in Rubanda and Kabale (90% and 70% respectively) but less preferred (40%) in Rukiga. This preference discrepancy was associated with location of Rukiga district, far away from Kachwekano-ZARDI, leading to additional transaction costs related to transport and travel time to and from the research station, thus reducing the farmers preference. Fewer farmers from Rukiga (40%) preferred Kachwekano-

ZARDI quality potato seed source was attributed to high transport costs and travel time to and from the research station, thus, the rest of smallholder farmers opted for other potato seed sources that were not necessarily quality potato seed sources. Transport costs and other logistical challenges play a crucial role in the uptake of new practices because of the additional costs involved [20] [40]. By reducing the distance that farmers need to travel to access an input significantly improved its uptake [41]. This finding also feeds into the need for Kachwekano-ZARDI to extend its distribution networks by partnering with local stores and local markets to ensure all the services offered by the institute such as supply of quality declared seed and extension services are extended nearer to the remote farmers through public private partnerships (PPP) arrangement.

3.4. Potato Tuber Size from Recycled Seed Sources Preferred by Farmers as Suitable Planting Material

Findings from the survey revealed that most farmers (60%, 50%, and 80%) in Rubanda, Kabale, and Rukiga districts respectively still preferred using small tubers as "seed" (Figure 4).



Source: *Field data*, 2022.

Figure 4. Size of potato tubers preferred as suitable seed material by farmers.

This finding contradicts with medium/large tubers that are recommended for high potato yield and productivity [42]. The use of small potato tubers as planting material by most smallholder farmers in these districts coupled with in preference

of recycled seed (Figure 4) by some farmers, particularly for Rukiga district (60%) underscores a widespread reliance on suboptimal planting materials which has an impact on crippling the potential of potato yield, and the overall agricultural productivity and sustainability. Thus, there is need for urgent and continuous extension services and training programs to create awareness to inform farmers on the benefits of transitioning from traditional practices and yarn for innovative intensification potato practices.

3.5. Attitude toward Potato-Legume Intercropping Systems Compared Commonly Used Potato-Based Intercropping Systems

Table 3. Main potato-based intercrops.

District	Rubanda	Kabale	Rukiga
Companion crop	Percent of farmers (n = 265)		
Beans/legumes	10	20	30
Maize/cereals	50	30	40
Onions/cabbages/vegetables	30	40	10
Other crops	10	10	20

Source: *Field data*, 2022.

Survey findings revealed that potato-legume intercropping was among the least preferred cropping systems for both Rubanda, Kabale, and Rukiga districts (10%, 20% and 30% respectively) (Table 3). From an ecosystem standpoint, the role of legumes such as beans in improving soil fertility cannot be over-emphasized [43] [44]. For instance, beans fix atmospheric nitrogen, providing a natural source of fertilizer into the soil, thus reducing the need for additional nitrogen inputs [44]. This not only enhance yield for the companion crop but also promotes ecological sustainability by minimizing the environmental impact associated with synthetic fertilizers. Relatedly, the complementary growth habits of some companion crops such as potato and beans grown together enables efficient utilization of resources and space, resulting in enhanced land productivity and economic returns for farmers [43]. This finding calls for continuous extension services and training programs to raise awareness on benefits of transitioning from traditional practices and yarn for innovative practices that enhance food security, resilient, and sustainable agricultural landscapes.

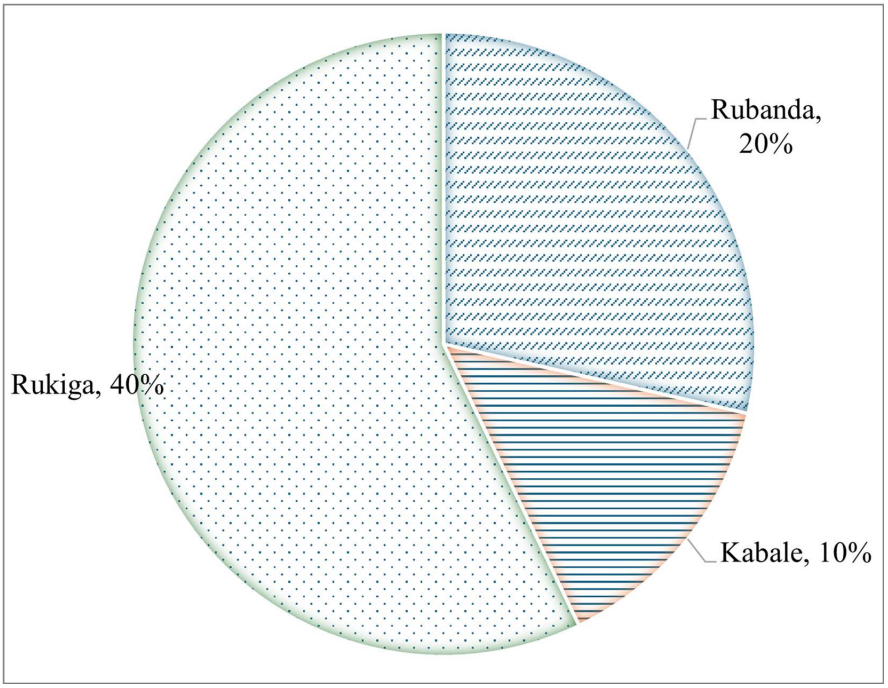
3.6. Use of Farmyard Manure by Farmers to Improve Soil Fertility

Survey results revealed that there was generally low use of farmyard manure (20%, 10% and 40%) for Rubanda, Kabale and Rukiga districts respectively because manure was associated with the harboring pests in potato gardens (Figure 5).

"*When you use farmyard manure, you invite pests in your garden, especially* '*kanyarugongo*' (*Thrips*) *which climbs up the potato shoot and feeds on the leaves*

at night" (Masobera Elinorah, an elderly farmer, Kabale district).

With such beliefs among smallholder farmers in a situation where use of inorganic fertilizers is very limited, balancing soil fertility and issues related to a balanced ecological system such as climate change becomes a challenge [45] [46]. Using farmyard manure is a low-production cost innovation that ensures an environmentally friendly product that is key for the growth conditions of crops than to other methods [45]. Farmyard manure has high potential to supply crop nutrients over a longer period than inorganic fertilizers [46]. From a policy perspective, increased use of manure in agriculture has a positive impact on the environment [47]. Thus, there is need for extension services to overturn the non-enterprising farmer attitudes and perceptions towards use of farmyard manure not only as a cost-saving innovative practice but also environmentally friendly practice for enhanced potato yield and productivity and sustainable environment.



Source: *Field data*, 2022.

Figure 5. Use of farmyard manure by potato farmers.

4. Conclusions and Recommendations

This study underscores the crucial role of attitudes in the uptake of innovative agricultural practices among smallholder farmers in Southwestern Uganda, particularly in the context of potato crop intensification innovation which was implemented by CARP+, a RUFORUM project that was implemented by Makerere University between 2018 and 2021. Data were collected from 265 respondents purposively selected because of their active participation in the project and analysed quantitatively using descriptive statistics.

Results revealed that there was a general shift from use of traditional practices

towards potato crop intensification innovations such as potato-legume intercropping systems and use of recommended spacing. However, several negative attitudes toward use of improved seed from research institutions and use of soil fertility management practices such as fertilizers and farmyard manure. Preference for use of large and medium potato tubers as planting materials in cases where cycled potato seed was used also remained lower due to limited knowledge.

The study recommended continuous extension educational programmes to create awareness and clear extension messages on the benefits of using potato crop intensification innovative practices such as quality declared seed and fertilizers. The study also recommended Kachwekano-ZARDI to strengthen quality potato seed supply chain and distribution networks to remote areas by establishing certification processes and protocols for informal seed players such as farmers, local stores and local markets to ensure seed quality and accessibility through public-private partnerships (PPP) arrangements. Finally, there is a need for adequate use of farmyard manure as a cost-saving method that does not only enhance potato yield and productivity but also is environmentally friendly.

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Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Cavallo, E., Ferrari, E., Bollani, L. and Coccia, M. (2014) Attitudes and Behaviour of Adopters of Technological Innovations in Agricultural Tractors: A Case Study in Italian Agricultural System. *Agricultural Systems*, **130**, 44-54. https://doi.org/10.1016/j.agsy.2014.05.012

[2] Chuang, J., Wang, J. and Liou, Y. (2020) Farmers' Knowledge, Attitude, and Adoption of Smart Agriculture Technology in Taiwan Region. *International Journal of Environmental Research and Public Health*, **17**, Article No. 7236. https://doi.org/10.3390/ijerph17197236

[3] Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G.W. and Nieuwenhuis, M. (2014) The Role of Knowledge, Attitudes and Perceptions in the Uptake of Agricultural and Agroforestry Innovations among Smallholder Farmers in Sub-Saharan Africa. *International Journal of Agricultural Sustainability*, **13**, 40-54. https://doi.org/10.1080/14735903.2014.912493

[4] Nair, I. and Das, M. (2011) Analysis of Recent Studies Undertaken for Assessing Acceptance of Technology among Teachers Using TAM. *International Journal of Computer Applications*, **32**, 38-46.

[5] Ssekyanzi, A., Nevejan, N., Kabbiri, R., Wesana, J. and Stappen, G.V. (2022) Knowledge, Attitudes, and Practices of Fish Farmers Regarding Water Quality and Its Management in the Rwenzori Region of Uganda. *Water*, **15**, Article No. 42. https://doi.org/10.3390/w15010042

[6] Zeweld, W., Van Huylenbroeck, G., Tesfay, G. and Speelman, S. (2017) Smallholder Farmers' Behavioural Intentions Towards Sustainable Agricultural Practices. *Journal of Environmental Management*, **187**, 71-81. https://doi.org/10.1016/j.jenvman.2016.11.014

[7] Cakirli Akyüz, N. and Theuvsen, L. (2020) The Impact of Behavioral Drivers on Adoption of Sustainable Agricultural Practices: The Case of Organic Farming in Turkey. *Sustainability*, **12**, Article No. 6875. https://doi.org/10.3390/su12176875

[8] Chimoita, E., Onyango, C., Gweyi-Onyango, J. and Kimenju, J. (2019) Socio-Economic and Institutional Factors Influencing Uptake of Improved Sorghum Technologies in Embu, Kenya. *East African Agricultural and Forestry Journal*, **83**, 69-79. https://doi.org/10.1080/00128325.2019.1597568

[9] Mutenje, M., Kankwamba, H., Mangisonib, J. and Kassie, M. (2016) Agricultural Innovations and Food Security in Malawi: Gender Dynamics, Institutions and Market Implications. *Technological Forecasting and Social Change*, **103**, 240-248. https://doi.org/10.1016/j.techfore.2015.10.004

[10] Ntshangase, N., Muroyiwa, B. and Sibanda, M. (2018) Farmers' Perceptions and Factors Influencing the Adoption of No-Till Conservation Agriculture by Small-Scale Farmers in Zashuke, Kwazulu-Natal Province. *Sustainability*, **10**, Article No. 555. https://doi.org/10.3390/su10020555

[11] Parvez, S.M., Azad, R., Rahman, M., Unicomb, L., Ram, P.K., Naser, A.M., *et al*. (2018) Achieving Optimal Technology and Behavioral Uptake of Single and Combined Interventions of Water, Sanitation Hygiene and Nutrition, in an Efficacy Trial (WASH Benefits) in Rural Bangladesh. *Trials*, **19**, Article No. 358. https://doi.org/10.1186/s13063-018-2710-8

[12] Rust, N.A., Ptak, E.N., Graversgaard, M., Iversen, S., Reed, M.S., de Vries, J.R., *et al*. (2020) Social Capital Factors Affecting Uptake of Sustainable Soil Management Practices: A Literature Review. *Emerald Open Research*, **2**, Article No. 8. https://doi.org/10.35241/emeraldopenres.13412.2

[13] Unekwu, O., Mojisola, A.O., Tina, E. and Ogala, D. (2020) Perception and Uptake of Aquaculture Technologies in Kogi State, Central Nigeria: Imperative for Improved Management Practices for Sustainable Aquaculture Development. *African Journal of Agricultural Research*, **16**, 819-828. https://doi.org/10.5897/ajar2019.14558

[14] Damba, O.T., Ansah, I.G.K., Donkoh, S.A., Alhassan, A., Mullins, G.R., Yussif, K., *et al*. (2020) Effects of Technology Dissemination Approaches on Agricultural Technology Uptake and Utilization in Northern Ghana. *Technology in Society*, **62**, Article ID: 101294. https://doi.org/10.1016/j.techsoc.2020.101294

[15] Rosen, B. and Goodson, P. (2013) A Recommendation to Use the Diffusion of Innovations Theory to Understand School Nurses' Role in HPV Vaccine Uptake. *International Quarterly of Community Health Education*, **34**, 37-49. https://doi.org/10.2190/iq.34.1.d

[16] Toma, L., Barnes, A.P., Sutherland, L.-A., Thomson, S., Burnett, F. and Mathews, K. (2016) Impact of Information Transfer on Farmers' Uptake of Innovative Crop Technologies: A Structural Equation Model Applied to Survey Data. *The Journal of Technology Transfer*, **43**, 864-881. https://doi.org/10.1007/s10961-016-9520-5

[17] Conway, S.F., McDonagh, J., Farrell, M. and Kinsella, A. (2021) Going against the Grain: Unravelling the Habitus of Older Farmers to Help Facilitate Generational Renewal in Agriculture. *Sociologia Ruralis*, **61**, 602-622. https://doi.org/10.1111/soru.12355

[18] Kassie, M., Ndiritu, S.W. and Stage, J. (2014) What Determines Gender Inequality in

Household Food Security in Kenya? Application of Exogenous Switching Treatment Regression. *World Development*, **56**, 153-171. https://doi.org/10.1016/j.worlddev.2013.10.025

[19] Antwi-Agyei, P. and Stringer, L.C. (2021) Improving the Effectiveness of Agricultural Extension Services in Supporting Farmers to Adapt to Climate Change: Insights from Northeastern Ghana. *Climate Risk Management*, **32**, Article ID: 100304. https://doi.org/10.1016/j.crm.2021.100304

[20] Atukunda, G., Atekyereza, P., Walakira, J. and State, A.E. (2022) Increasing Farmers' Access to Aquaculture Extension Services: Lessons from Central and Northern Uganda. *Uganda Journal of Agricultural Sciences*, **20**, 49-68. https://doi.org/10.4314/ujas.v20i2.5

[21] Norton, G.W. and Alwang, J. (2020) Changes in Agricultural Extension and Implications for Farmer Adoption of New Practices. *Applied Economic Perspectives and Policy*, **42**, 8-20. https://doi.org/10.1002/aepp.13008

[22] Nahayo, A., Omondi, M.O., Zhang, X., Li, L., Pan, G. and Joseph, S. (2017) Factors Influencing Farmers' Participation in Crop Intensification Program in Rwanda. *Journal of Integrative Agriculture*, **16**, 1406-1416. https://doi.org/10.1016/s2095-3119(16)61555-1

[23] Rodthong, W., Kuwornu, J.K.M., Datta, A., Anal, A.K. and Tsusaka, T.W. (2020) Factors Influencing the Intensity of Adoption of the Roundtable on Sustainable Palm Oil Practices by Smallholder Farmers in Thailand. *Environmental Management*, **66**, 377-394. https://doi.org/10.1007/s00267-020-01323-3

[24] Haughton, D., *et al*. (2014) Reciprocity in Social Networks—A Case Study in Tamil Nadu, India. *CS-BIGS*, **5**, 126-131.

[25] Stutzman, E., Molnar, J., Atukunda, G. and Walakira, J. (2017) Understanding the Role of Fish Farmer Associations as Intermediaries for the Commercialization of Aquaculture in Uganda. *Fisheries and Aquaculture Journal*, **8**, Article ID: 1000214. https://doi.org/10.4172/2150-3508.1000214

[26] Castiblanco Jimenez, I.A., Cepeda García, L.C., Marcolin, F., Violante, M.G. and Vezzetti, E. (2021) Validation of a TAM Extension in Agriculture: Exploring the Determinants of Acceptance of an e-Learning Platform. *Applied Sciences*, **11**, Article No. 4672. https://doi.org/10.3390/app11104672

[27] Mugo, D., Njagi, K., Chemwei, B. and Motanya, J. (2017) The Technology Acceptance Model (TAM) and Its Application to the Utilization of Mobile Learning Technologies. *British Journal of Mathematics & Computer Science*, **20**, 1-8. https://doi.org/10.9734/bjmcs/2017/29015

[28] Pinthukas, N. (2015) Farmers' Perception and Adaptation in Organic Vegetable Production for Sustainable Livelihood in Chiang Mai Province. *Agriculture and Agricultural Science Procedia*, **5**, 46-51. https://doi.org/10.1016/j.aaspro.2015.08.007

[29] Akba, S., *et al*. (2021) An Analysis of Variables Predicting Attitudes of High School Students toward Teaching Profession: A Case Study. In: Erçetin, Ş.Ş. and Potas, N., Eds., *Chaos, Complexity and Leadership* 2017: *Explorations of Chaos and Complexity Theory*, Springer, 535-549. https://doi.org/10.1007/978-3-319-89875-9

[30] Rezaei, R., Safa, L., Damalas, C.A. and Ganjkhanloo, M.M. (2019) Drivers of Farmers' Intention to Use Integrated Pest Management: Integrating Theory of Planned Behavior and Norm Activation Model. *Journal of Environmental Management*, **236**, 328-339. https://doi.org/10.1016/j.jenvman.2019.01.097

[31] Namugga, P., Sibiya, J., Melis, R. and Barekye, A. (2018) Combining Ability Analysis of Earliness and Yield of Potato (*Solanum tuberosum* L.) Genotypes in Uganda. *Eu-*

phytica, **214**, Article No. 116. https://doi.org/10.1007/s10681-018-2201-8

[32] Ekunwe, P.A. and Emokaro, C.O. (2009) Technical Efficiency of Catfish Farmers in Kaduna, Nigeria. *Journal of Applied Sciences Research*, **5**, 802-805.

[33] Ike, N. and Roseline, O. (2001) Adoption of Aquaculture Technology by Fish Farmers in Imo State of Nigeria.

[34] Al-Khraif, R.M., Salam, A.A. and Rashid, M.F.A. (2022) Demographic Dividend in Saudi Arabia: From Age Structural Changes to Economic Gains. *Journal of Economics and Management*, **44**, 19-37. https://doi.org/10.22367/jem.2022.44.02

[35] Uganda National Bureau of Statistics (2021) Uganda Bureau of Statistics 2021 Statistical Abstract. Uganda Bureau of Statistics, 1-341.

[36] Adom, P.K. and Adams, S. (2020) Decomposition of Technical Efficiency in Agricultural Production in Africa into Transient and Persistent Technical Efficiency under Heterogeneous Technologies. *World Development*, **129**, Article ID: 104907. https://doi.org/10.1016/j.worlddev.2020.104907

[37] Tadele, Z. (2017) Raising Crop Productivity in Africa through Intensification. *Agronomy*, **7**, Article No. 22. https://doi.org/10.3390/agronomy7010022

[38] Khan, M.N., Mobin, M., Abbas, Z.K. and Alamri, S.A. (2018) Fertilizers and Their Contaminants in Soils, Surface and Groundwater. In: Dellasala, D.A. and Goldstein, M.I., Eds., *Encyclopedia of the Anthropocene*, Elsevier, 225-240. https://doi.org/10.1016/b978-0-12-809665-9.09888-8

[39] Srivastav, A.L. (2020) Chemical Fertilizers and Pesticides: Role in Groundwater Contamination. In: Prasad, M.N.V., Ed., *Agrochemicals Detection, Treatment and Remediation*, Elsevier, 143-159. https://doi.org/10.1016/b978-0-08-103017-2.00006-4

[40] Juma, C. (2015) Agricultural Innovation Systems. In: Juma, C., Ed., *The New Harvest*, Oxford University Press, 83-116. https://doi.org/10.1093/acprof:oso/9780190237233.003.0004

[41] Vandevelde, S., Van Campenhout, B. and Walukano, W. (2021) Accounting for Spillovers in Assessing the Effectiveness of Video Messages to Improve Potato Seed Quality: Evidence from Uganda. *The Journal of Agricultural Education and Extension*, **27**, 503-534. https://doi.org/10.1080/1389224x.2021.1880454

[42] Masarirambi, M.T., Mandisodza, F.C., Mashingaidze, A.B. and Bhebhe, E. (2012) Influence of Plant Population and Seed Tuber Size on Growth and Yield Components of Potato (*Solanum tuberosum*). *International Journal of Agriculture and Biology*, **14**, 545-549.

[43] Gitari, H.I., Nyawade, S.O., Kamau, S., Karanja, N.N., Gachene, C.K.K., Raza, M.A., *et al*. (2020) Revisiting Intercropping Indices with Respect to Potato-Legume Intercropping Systems. *Field Crops Research*, **258**, Article ID: 107957. https://doi.org/10.1016/j.fcr.2020.107957

[44] Nakibuule, J., Obala, J., Kigambo, M., Kajunju, N.H.B. and Mugisha, J. (2022) Effect of Potato-Bean Intercrop Arrangement, Plant Spacing and Fertiliser Usage on Plant Growth and Tuber Yield in Different Environments. *Makerere University Journal of Agricultural and Environmental Sciences*, **11**, 107-126.

[45] Goldan, E., Nedeff, V., Barsan, N., Culea, M., Panainte-Lehadus, M., Mosnegutu, E., *et al*. (2023) Assessment of Manure Compost Used as Soil Amendment—A Review. *Processes*, **11**, Article No. 1167. https://doi.org/10.3390/pr11041167

[46] Jan, M., Hussain, S., Haq, M.A.U., Iqbal, J., Ahmad, I., Aslam, M., *et al*. (2020) Effect of Farm Yard Manure and Compost Application on Transgenic BT Cotton Varieties. *Pakistan Journal of Agricultural Research*, **33**, 371-380.

https://doi.org/10.17582/journal.pjar/2020/33.2.371.380

[47] Hou, Y., Velthof, G.L., Case, S.D.C., Oelofse, M., Grignani, C., Balsari, P., *et al.* (2018) Stakeholder Perceptions of Manure Treatment Technologies in Denmark, Italy, the Netherlands and Spain. *Journal of Cleaner Production*, **172**, 1620-1630. https://doi.org/10.1016/j.jclepro.2016.10.162